

The Examiner asserts that the impurities in the copper alloys recited in JP '443, JP '351, JP '562, and JP '162 would inherently possess the impurities recited in pending claims.

As noted in the September 23<sup>rd</sup> Amendment, each of the cited prior art references describe *refined* copper microalloys. "The purity of electrorefined copper is 99.9+ % Cu, less than 0.004% metallic impurities (including sulphur)." See Biswas and Davenport, Extractive Metallurgy of Copper, Pergamon Press, 2<sup>nd</sup> Edition (1980), pages 295-296 (a copy of which is attached). Therefore, refined copper microalloys contain little if any impurities, let alone the ingredients in the amounts specified in the presently claimed invention.

The use of the term "impurities" in the present application is not an admission that refined copper microalloy inherently contains the specified amount of the ingredient. Rather, it refers to elements which might be found naturally in copper or elements artificially added to copper.

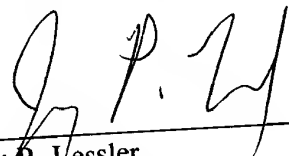
None of these references disclose or suggest a copper microalloy having all of the impurities in the amounts recited in the pending claims.

For the foregoing reasons, the cited prior art fails to render obvious the claimed invention. Accordingly, applicants respectfully request withdrawal of this rejection.

In view of the above amendments and remarks, it is respectfully requested that the application be reconsidered and that all pending claims be allowed and the case passed to issue.

If there are any other issues remaining which the Examiner believes could be resolved through either a Supplemental Response or an Examiner's Amendment, the Examiner is respectfully requested to contact the undersigned at the telephone number indicated below.

Respectfully submitted

  
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Marked-Up Claim  
Accompanying March 21, 2003 Supplemental Amendment  
For U.S. Serial No. 09/499,207  
(Docket No. 2136/0G684)

9. (Thrice Amended) A method for the manufacture of a copper microalloy containing lead, comprising:

(a) mixing a copper alloy containing [(1)] S, Se, As, Sb, Bi, Sn, Zn, Ni, Fe, Ag, or Te impurities in amounts of the order of tens of weight ppm [and (2) less than 80 weight ppm of the impurities Zn, Ag, Cd, Sb, Ni, Fe, Bi, Sn and S] with lead to yield a microalloy having at least 200 weight ppm of lead, wherein the copper alloy contains Zn, Fe, Ni, Sn, and Ag impurities in amounts of the order of tens of weight ppm;

(b) continuous casting the microalloy from step (a); and

(c) heating the microalloy from step (b) at 550-650° C for 5-600 seconds to decrease its half-softening temperature, annealing temperature, and recrystallization temperature to below 200° C.

Pending Claims  
(After March 21, 2003 Supplemental Amendment)  
For U.S. Serial No. 09/499,207  
(Docket No. 2136/0G684)

5. (Twice Amended) A method for the manufacture of a copper microalloy comprising:

(a) mixing a copper alloy containing S, Se, As, Sb, Bi, Sn, Zn, Ni, Fe, Ag or Te impurities in amounts of the order of tens of weight ppm, with lead to yield a microalloy having a final concentration of at least 200 weight ppm of lead, wherein the copper alloy contains Zn, Fe, Ni, Sn, and Ag impurities in amounts of the order of tens of weight ppm; and

(b) continuous casting the microalloy.

7. The method of claim 5, wherein the microalloy has a lead content of more than 300 weight ppm.

8. The method of claim 5, wherein the microalloy has a lead content of more than 350 weight ppm.

9. (Thrice Amended) A method for the manufacture of a copper microalloy containing lead, comprising:

(a) mixing a copper alloy containing S, Se, As, Sb, Bi, Sn, Zn, Ni, Fe, Ag, or Te impurities in amounts of the order of tens of weight ppm with lead to yield a

microalloy having at least 200 weight ppm of lead, wherein the copper alloy contains Zn, Fe, Ni, Sn, and Ag impurities in amounts of the order of tens of weight ppm;

(b) continuous casting the microalloy from step (a); and

(c) heating the microalloy from step (b) at 550-650° C for 5-600

seconds to decrease its half-softening temperature, annealing temperature, and recrystallization temperature to below 200° C.

10. The method of claim 9, wherein the microalloy has a lead content of more than 300 weight ppm.

11. The method of claim 9, wherein the microalloy has a lead content of more than 350 weight ppm.

12. The method of claim 9, wherein the hydrogen content of the microalloy is 0.5-0.7 weight ppm after casting.

14. The method of claim 9, whereby the electrical conductivity of the microalloy is increased to values greater than 101% IACS.

15. (Amended) A method for the manufacture of a copper microalloy comprising:

(a) mixing a copper alloy consisting essentially of copper and one or more of S, Se, As, Sb, Bi, Sn, Zn, Ni, Fe, Ag and Te impurities in amounts of the order of

tens of weight ppm, with lead to yield a microalloy having a final concentration of at least 200 weight ppm of lead, wherein the copper alloy contains Zn, Fe, Ni, Sn, and Ag impurities in amounts of the order of tens of weight ppm; and

(b) continuous casting the microalloy.

17. The method of claim 15, wherein the microalloy has a lead content of more than 300 weight ppm.

18. The method of claim 15, wherein the microalloy has a lead content of more than 350 weight ppm.

19. (Amended) A method for the manufacture of a copper microalloy comprising:

(a) mixing a copper alloy consisting of copper and one or more of S, Se, As, Sb, Bi, Sn, Zn, Ni, Fe, Ag and Te impurities in amounts of the order of tens of weight ppm, with lead to yield a microalloy having a final concentration of at least 200 weight ppm of lead, wherein the copper alloy contains Zn, Fe, Ni, Sn, and Ag impurities in amounts of the order of tens of weight ppm; and

(b) continuous casting the microalloy.

21. The method of claim 19, wherein the microalloy has a lead content of more than 300 weight ppm.

22. The method of claim 19, wherein the microalloy has a lead content of more than 350 weight ppm.

## ELECTROLYTIC REFINING OF COPPER

Virtually all copper receives electrolytic treatment during its production from ore. It undergoes either: (a) electrorefining from impure copper anodes or (b) electrowinning from leach or solvent extraction solutions (Chapter 16). Electrorefining is discussed first (this chapter) because it is used to produce much more cathode copper (about 95% of production) than electrowinning† (about 5% of production).

Electrorefining consists of electrochemically dissolving copper from impure anodes and selectively plating the dissolved copper in pure form onto copper cathodes. Electrorefining serves two purposes:

- (a) It eliminates impurities which are harmful to the electrical and mechanical properties of copper. The purity of electrorefined copper is 99.9+ % Cu, less than 0.004 % metallic impurities (including sulphur); which is suitable for all industrial uses including electrical engineering applications. This purity is not obtainable by fire-refining techniques alone.
- (b) It separates valuable impurities from the copper. These can then be recovered as by-product metals.

The industrial ranges of copper anode and cathode compositions are presented in Table 15.1 and a flowsheet of a copper refining operation is shown in Fig. 15.1.

### 15.1 Principles of Electrolytic Copper Refining

The application of an electrical potential between a copper anode (positive electrode) and a copper cathode (negative electrode), both

† Electrowinning is the last chemical step of hydrometallurgical copper processing. The correct sequence of reading for hydrometallurgical extraction is leaching (Chapter 13); solvent extraction (Chapter 14); electrowinning (Chapter 16).



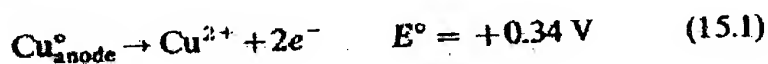
TABLE 15.1. INDUSTRIAL RANGE OF ANODE AND CATHODE COMPOSITIONS IN MODERN REFINERIES

Element	Anodes (range of %)	Cathodes (range of %)
Cu	99.4-99.8	99.99 +
O	0.1-0.3	(not included in analysis)
Ni	0-0.5	trace-0.0010
Pb	0-0.1	trace-0.0005
As	0-0.3*	trace-0.0002
Sb	0-0.3*	trace-0.0002
Se	0-0.02	trace-0.0002
Fe	0.002-0.03	0.0002-0.0020
Te	0-0.001	trace-0.0001
S	0.001-0.003	0.0004-0.0010
Bi	0-0.01	trace-0.0001
Ag	trace-0.1	0.0005-0.001
Au	0-0.005	0-0.00001

\* Eichrodt and Schloen (1954).

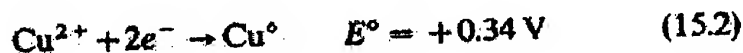
immersed in a cell containing an acidified copper sulphate solution, causes the following reactions and processes to take place:

- (a) Copper is electrochemically dissolved from the anode into the solution, i.e.



producing copper cations plus electrons.

- (b) The electrons produced by reaction (15.1) are conducted towards the cathode through the external circuit and power supply.  
 (c) The  $\text{Cu}^{2+}$  cations in the solution migrate by diffusion and convection to the negative electrode (cathode).  
 (d) The electrons and the  $\text{Cu}^{2+}$  ions recombine at the cathode surface to produce copper metal which plates on the cathode, i.e.



The net effects are the electrochemical dissolution of copper from the anode; the migration of electrons and copper ions towards the cathode;